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This report is a follow-up study of the 1964-65 School Mathematics Study Group (SMSG) pilot program on mathematics learning of culturally disadvantaged children. In the pilot program, the School Mathematics Study Group was interested in determining the effectiveness of existing SMSG materials in developing materials for teachers emphasizing techniques for providing disadvantaged children with experiences necessary for the formation of fundamental concepts of arithmetic. A testing program was instituted to obtain objective data by which various comparisons might be made. The testing program was used to determine individual assessments in Visual Recognition, Visual Memory, Color Inventory, Geometric Shapes, Number Symbols, Counting Symbols, Counting, Place Value, Ordinal Numbers, Pairing, Equivalent Sets, Vocabulary, and Ordering and Classifying. An interpretation of the data obtained from the testing program is indicated for each of the above areas. (RP)

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SCHOOL MATHEMATICS STUDY GROUP

SMSG REPORTS

No. 4

The Special Curriculum Project: 1965-1966
Pilot Program on Mathematics Learning of Culturally Disadvantaged Primary School Children

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INTRODUCTION

During the school year, 1964-1965, the School Mathematics Study Group conducted a pilot program on mathematics learning of culturally disadvantaged children. In the sense that the same kinds of problems and population were involved, the study reported here is a follow-up study in 1965-1966 of the pilot program. However, only a few students being followed were the same in both years. In the pilot program, the School Mathematics Study Group was interested in determining the effectiveness of existing SMSG materials in developing "materials for teachers emphasizing techniques for providing disadvantaged children with experiences necessary for the formation of fundamental concepts of arithmetic."[1] Determining the effectiveness of the SMSG materials led to curriculum comparison for this population, and some preliminary findings from such comparisons were contained in a previous report,[2] together with a more detailed statement of the purpose of the study, and procedures which have been utilized.

In the follow-up project, the SMSG was concerned with yet another problem. Since these were to be pilot programs, it seemed pertinent to ask about the kinds of statistical inferences that one might be able to gather from data, and perhaps incorporate the same kind of determination in future experimental designs. Answers to such questions were particularly relevant since, relatively speaking, the sample size obtainable for a study might not be so large that minor ripples in the sea of data would not show up as major disturbances; moreover, one cannot afford to introduce additional ripples in such a sea through careless treatment of statistics. Mindful of such possibilities, we intend to be more conservative in our interpretation of the data on these pages.

Experimental Centers

In the first year of the pilot program, classrooms located in Boston, Chicago, Detroit, Miami, Oakland (California), and Washington, D. C.

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1. Recommendation of SMSG Ad Hoc Committee on Below Average Achievers.

2. SMSG Reports, No. 2: The Special Curriculum Project: Pilot Program on Mathematics Learning of Culturally Disadvantaged Primary Children, Stanford, 1966.

participated in the study. Consultancy support, textbooks, and manipulative materials were provided the classroom teachers in each center. All the teachers, center coordinators, and consultants met members of the SMSG headquarters staff in plenary sessions four times during the year to discuss progress, report difficulties, and to recommend modifications of the existing SMSG text materials so that they can address themselves to this population.

In the second year, two centers did not continue with the study because their center coordinators were on leaves of absence from their respective positions to engage in their own writing or research projects. However, three new centers joined the study at this time. These new centers were located in Austin (Texas), Charleston (West Virginia), and Chula Vista (California). The classes in the Austin center were located in Round Rock, approximately 20 miles from Austin. In Charleston, the West Virginia State Department of Education solicited the cooperation of two neighboring cities: Glen White, a suburb of Beckley; and London, a community which has felt the impact of the depressed Appalachia. Chula Vista is a suburb of San Diego (California); here, a characteristic problem of the disadvantaged is concerned with English as the second language, the first being Spanish.

In addition to these changes, the centers in Oakland and Washington, D. C. expanded. The number of new classes in Oakland included 25 kindergarten and 27 first grade classes. The number of kindergarten classes in Washington was 27 and the first grade classes in this center numbered 54. Altogether, more than 150 classes were involved in the second year study; of these, 143 were new to the project. Since many of the continuing classes became statistically contaminated by a variety of factors--including sometimes, entire reshuffling of the class--attention in this report is concentrated on the new classes in the study.

Ancillary Services

In line with the procedure established in the first year study, administrative and subject-matter supports were provided in the second year for each experimental center through the staffing of center coordinators and mathematics consultants. For the large centers (Oakland and Washington), consultancy took the form of inservice meetings in order that the teachers can be ensured of regular assistance. Each inservice class was designed to offer two kinds of help: pedagogical and mathematical. For this reason, two instructors were assigned to each inservice class: one to define the

mathematical concepts, and one to suggest ways of translating these ideas into meaningful terms for these children. In anticipation of this phase of the project, an inservice textbook was written especially for these courses during the summer of 1965. Here, too, attention was paid to the problem of making the mathematics and the mathematical activities meaningful for these children. Locations of the topics as they are developed in the SMSG elementary mathematics program were identified to reveal their schedule of appearance, giving an indication of the role each concept plays in the curriculum. In the inservice text are also included possible suggestions for presenting some of these topics.

Beyond such ancillary services, arrangements were made at the request of the District of Columbia Public Schools to provide a teacher specialist for the experimental center there. These extra services were furnished with the hope that teachers in so large a school district might have mathematical and pedagogical supports that at least approximate better the supplemental attention that smaller districts might give to their teachers because their supervisors are more able to meet with the teachers from the standpoint of time commitment.

Testing Program

A testing program was instituted in order to obtain objective data by which various comparisons might be made. Physical limitations and statistical considerations motivated an evaluation using five children per class as class samples for the large centers, Oakland and Washington. Thus for these centers, the class was taken as a unit, with each statistic being the corresponding mean derived from the scores of the five children. This treatment reduced drastically the size of the population sample, but it had the advantage of increased stability in measures as well as increased reliability.

The testing program consisted of both an individual assessment and a group test using paper and pencil. However, the group test was not administered as a pretest to the entering kindergarten children as they were not considered ready for paper and pencil work at the time. Therefore, in comparing growth, we have only the results of the individual assessments at our disposal. Prior to administration of these individual tests, testers for each center were briefed in order to gain uniformity in test administration.

Pretests and posttests were developed for each of three groups of children:

(1) those in kindergarten in Chula Vista;

(2) those in kindergarten in Oakland and Washington;

(3) all children in first grade.

Thus, six basic tests were developed. These tests were revisions of corresponding tests given in the first year study. Items such as those on ability to recognize objects or drawings appearing in the first year study were deleted from most of the forms the following year since their results had not been shown to have much promise in the past. The exception was in the pretest for the Chula Vista kindergarten children. Here, these items were retained on the basis that the items might give some clues on the ability of these children to name objects in drawings or objects in the form of models such as plastic horses, ceramic dogs, and so on. Even for this population which regards English as a second language, the items did not prove discriminating enough (for example, in Object Recognition, out of 22 objects, the average number correctly named was almost 19; in Drawing Recognition, out of 7 drawings, the average number correctly named was approximately six and one half). The results obtained from the second year study indicated that most of the items that had been deleted from all assessments except those for the Chula Vista kindergarten children (for example, Matching Colors), could have been dispensed with equally well from the Chula Vista tests.

Aside from the six basic forms mentioned above, one other test form was printed. This was one in which the items in the kindergarten test were rearranged in sequence in order to determine whether order of presenting the items might significantly influence the results. The results of this substudy will be reported also on these pages. A schedule of assessments showing whether an item was included in the pretest in September 1965 or in the posttest in May 1966 (or in both) is given in Table 1. Although the same item might have been listed for both the kindergarten and first grade groups, the items often vary in degree of difficulty. This same kind of variation obtains occasionally between pretest and posttest items. It is due to such variations that particular caution must be exercised in reading the data. The same score attained for the item does not necessarily show a static situation. If the assessment in the posttest demands greater depth in understanding, for example, improvement might have occurred even though the score

Table 1

SCHEDULE OF ASSESSMENTS: INDIVIDUAL TESTS BY GRADES

Assessments Made		Kindergarten				First Grade	
		Chula Vista		Oakland-Washington		All Centers	
		Initial	Final	Initial	Final	Initial	Final
Visual Recognition	Objects	x					
	Pictures	x					
Visual Memory	Objects	x	x	x	x	x	
	Pictures		x	x	x	x	x
Color	Matching	x	x				
	Naming	x	x	x	x	x	x
	Identifying	x	x	x	x	x	x
Geometric Shapes	Matching	x	x	x			
	Naming	x	x	x	x	x	x
	Identifying	x	x	x	x	x	x
Number Symbols	Naming						x
	Identifying	x	x	x	x	x	x
	Writing	x	x	x	x	x	x
Counting	Objects	x	x	x	x	x	
	Pictures	x	x	x	x	x	x
	Rote by Ones	x	x	x	x	x	x
	Rote by Tens						x
Place Value	Naming						x
	Forming						x
Ordinal Numbers			x		x	x	x
Pairing							x
Equivalent Sets			x		x		x
Vocabulary			x	x	x	x	
Ordering and Classifying			x	x	x	x	x

in the posttest was the same as the score in the pretest. On the other hand, if the posttest contains more subentries allowing for possibility of a higher score measuring the same degree of competence, a higher score in the posttest might be expected for equivalence in measure of the item. To help with interpretation of the data, we shall mention, when it seems warranted in our discussion, whether changes do occur in the assessments.

The nature of the testing program then is such that growth cannot always be read from raw scores. This creates a problem in that any attempt to present the data entirely from the standpoint of significance of differences between raw data for pretest and posttest measures is likely to be distorted in interpretation. Since the treatment groups differed on measures of initial level of achievement, a covariance technique was used to give estimates of what various mean scores in the posttests would have been had the groups been comparable on the pretests. It is the difference in adjusted means between the experimental and comparison classes thus obtained that is tested for significance for selected criterion variables.

INDIVIDUAL ASSESSMENTS

Visual Recognition[3]

An assessment relating to Visual Recognition was given to only one group of children; namely, the kindergarten children in Chula Vista. The task was to identify, by naming, various objects or representations of objects according to two modes of testing. In Object Recognition, concrete plastic models or actual objects (if feasible) were shown for identification by the child. In Picture Recognition, the same requirement was made, referring this time to line drawings printed on cards. Objects used in each case, and the order of presentation were as listed below:

Objects: truck, chair, button, penny, orange, dog, box, car, nickel, pencil, key, apple, cat, clock, rubber bands, book, dime, banana, horse, string, crayon, cow.

Pictures: book, cat, dog, apple, money, car, clock.

For Object Recognition, with a sample population of 117, the scores ranged from a low of one person identifying correctly only 12 objects to three persons identifying correctly all 22. For the same population, in Picture Recognition, the range extended from a low of one person identifying correctly only 3 pictures to a high of 69 persons identifying all 7 pictures. The mean and sigma of each of these assessments are summarized in in the table below.

Table 2

VISUAL RECOGNITION

	Number of Subitems	Range	Mean	Sigma
Object Recognition	22	12 - 22	18.607	2.080
Picture Recognition	7	3 - 7	6.470	0.761

3. For specific instructions, see page 49.

The results seem to indicate that even for this group of children having English regarded as a second language, the task given was relatively easy. The large number of children (69 out of 117, or about 59 °/o) correctly identifying all 7 pictures apparently indicated a weakness in this assessment in that the ceiling had been placed too low to be sufficiently discriminating. Apart from this observation, no other attempt is made to interpret these results since no comparison was made with any other group in the study; nor was the item repeated in the posttest.

Visual Memory[4]

As was the case for Visual Recognition, assessment for Visual Memory was also approached via subtests using objects and using pictures. In each case, an original set of objects was displayed momentarily. The child next closed his eyes, and during that interval, another set was exchanged for the original. This set differed from the original in that one of the objects had been removed. The child was given three opportunities to recall the object that had been removed; if unsuccessful, he again closed his eyes, and during this interval, a new set was presented. The "new set" consisted of objects all different from those in the original set with one exception: the object that had been previously removed was restored in this reconstructed set. Thus, the child who might have missed through direct recalls in three attempts, would still have an opportunity to recall at this stage through recognition.

In the portion of the tests where objects were used to construct the sets, the tasks for both pretests and posttests were designed to be comparable. A few objects used in the pretest had to be replaced by other objects in the posttest because of inability in finding duplicate items in the quantity needed for the test kits. In the case of Visual Memory (Pictures), however, the pictures presented were exactly the same, although there were slight changes in the order of presenting each set of pictures. In other words, the pretest and posttest measures were intended to be comparable.

Visual Memory was not one of the criterion variables selected for test of significance since this selection was based on various mathematical abilities. It was involved as one of the covariates on the basis that many claims have been proposed for the contribution of this task (visual memory)

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4. For specific instructions and list of materials, see page 50.

to other abilities, such as the ability to identify number symbols, to name symbols by holding images in the mind, and so on. Whether such contribution bears out for various assessments in our experience will be mentioned as we discuss each assessment treated as a dependent variable. The tables below merely show some of the results obtained in our testing program without attempt at analyzing these results.

Table 3

VISUAL MEMORY - OBJECTS

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	272	195		388
Mean	3.619	3.845		4.054
Median	3.047	3.414	Not given in initial inventory	3.768
Sigma	1.125	1.090		0.804
Range: Min. - Max.	0 - 5	0 - 5		1 - 5
Maximum Possible	5	5		5

Table 4

VISUAL MEMORY - PICTURES

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	266	189	458	389
Mean	1.619	1.873	1.746	1.980
Median	0.769	1.167	1.049	1.581
Sigma	1.125	1.194	1.191	1.076
Range: Min. - Max.	0 - 4	0 - 4	0 - 4	0 - 4
Maximum Possible	4	4	4	4

Color Inventory[5]

Inventory to determine ability to discriminate colors was given in all the tests on two levels: to select from an array of cards, one printed in a given color, and to name the color of a designated card. In addition to these tasks of "Identifying Colors" and "Naming Colors", kindergarten children in Chula Vista were given the task of "Matching Colors". The colors involved and their order of presentation for each assessment were identical for both pretests and posttests, and identical in all forms of the kindergarten and first grade inventories. The following display shows the order of presentation:

Matching: green, blue, orange, brown, red, yellow.

Naming: orange, blue, red, black, brown, yellow, green.

Identifying: red, brown, green, orange, yellow, blue.

The decision to include "Matching Colors " for Chula Vista was based on the assumption that here, the scores attained for both the Identifying and Naming portions of the test might not truly reflect the child's ability to discriminate colors. It might be simply that he did not know the English names for the colors. The results of the testing seemed to support this conjecture, as is indicated in Table 5.

Table 5

INITIAL COLOR INVENTORY IN ONE CENTER: KINDERGARTEN

	Matching	Naming	Identifying
Sample N	116	116	117
Mean	5.819	4.940	4.547
Median	5.426	5.450	5.114
Sigma	0.569	2.382	1.963
Range: Min. - Max.	2 - 6	0 - 7	0 - 6
Maximum Possible	6	7	6

5. For specific instructions, see page 53.

In increasing order of difficulty, the tasks may be listed: Matching, Identifying, Naming. However, the order presented in the testing was such that Naming preceded Identifying since otherwise the results for Naming would have been invalidated. In reading the above table, one should keep in mind that the scales were not always the same from task to task. For example, in

Matching: a mean of 5.819 represents approximately 97 o/o of the 6 colors presented;

Naming: a mean of 4.940 represents approximately 71 o/o of the 7 colors presented;

Identifying: a mean of 4.547 represents approximately 76 o/o of the 6 colors presented.

What is not shown in Table 5 but showed up in the frequency counts is that in the initial inventory, out of 6 items, 101 of the 116 children were able to match the colors correctly. On the other hand, two modes may be noted in the assessment for Naming Colors. There was a small peak showing about 20 o/o of the children able to name only either 1 or 2 of the colors, and a larger peak showing about 58 o/o of the children able to name 6 or all 7 of the colors. In other words, this apparently indicated that in our sample, a child either could name most of the colors or could not name most of the colors; the intermediate cases were relatively few.

In Naming Colors, 6 out of 116 (about 5 o/o) of the children in Chula Vista could not name a single color, 10 could name only 1 color, and 12 could name only 2 colors. Thus, approximately 24.1 o/o of the kindergarten children in this center could name 2 or fewer colors. By contrast, approximately 8.6 o/o of the kindergarten children in the other centers could name 2 or fewer colors. Since the English language was expected to be a barrier in this center, included in the instructions to the testers for Chula Vista was the suggestion that if responses were poor, the tester might retest each item in Spanish. In the data summation, only the results of the initial scoring were considered official since immediate retesting introduced the factor of double exposure to the items. It should be mentioned in passing, however, that in scanning the results, many of the children who could not name any of the colors in English could name every one in Spanish. This difference in achievement could not be attributed alone to the factor of familiarity on a retest, even though our study had not been designed to look into this situation critically.

Color Inventory was not one of the criterion variables selected for test of significance. However, it was involved as one of the possible covariates for a number of other variables. Therefore, no comments beyond some slight mention of general tendency will accompany the display of results obtained in our testing at this time.

Table 6

NAMING COLORS

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	268	196	460	389
Mean	5.732	6.704	6.592	6.875
Median	5.490	6.310	6.331	6.457
Sigma	1.904	0.851	1.026	0.573
Range: Min. - Max.	0 - 7	0 - 7	0 - 7	0 - 7
Maximum Possible	7	7	7	7

Table 7

IDENTIFYING COLORS

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	268	196	460	389
Mean	5.169	5.760	5.696	5.940
Median	5.157	5.376	5.416	5.485
Sigma	1.681	0.885	1.021	0.496
Range: Min. - Max.	0 - 6	0 - 6	0 - 6	0 - 6
Maximum Possible	6	6	6	6

In the kindergarten classes, approximately 59 °/o of the children were able to identify all 6 colors correctly in the initial inventory and approximately 80 °/o identified all 6 correctly in the final inventory. In the first grade, these ratios were approximately 86 °/o and 97 °/o respectively. Clearly, the inventory in itself was not sufficiently discriminatory for the purpose.

As was pointed out before, naming was considered a more difficult task than identifying. The children who were able to name all 7 colors constituted approximately 40 °/o of the group in the pretest and about 72 °/o in the posttest. In the first grade, the ratios were 75 °/o and 93 °/o respectively. By comparison with the assessment for Identifying Colors, the one for Naming Colors showed greater strength in ability to discriminate; however, a closer look at its distribution still showed intense skewing toward the top as evident from the means and sigmas for each administration of the tests. Here, as in the assessments for Visual Recognition, the ceiling was obviously placed too low.

Geometric Shapes[6]

Assessments were made with regard to ability to differentiate four basic shapes by recognition (identifying) and by naming. A fifth shape, one in the form of an "L" , was included as a distractor. In addition to the Naming and Identifying tasks, one on Matching was given to the Chula Vista children in both pretest and posttest, and to all other kindergarten children in the initial inventory only. The rationale for including this phase was the same as for including the matching task in the color inventory: to separate results for sorting and classifying characteristics (such as color and shape) from results associated with knowing names for these characteristics. The tasks involved were identical for all centers--kindergarten and first grade--in the pretest, and for all centers in the posttest. The same shapes and directions applied to both pretests and posttests; only the order of presenting the shapes differed between initial and final inventories. The shapes and the order of presenting them are listed below for each assessment:

Matching	pretest :	circle, square, triangle, rectangle.
	posttest:	square, circle, rectangle, triangle.

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6. For specific instructions, see page 55.

Naming	pretest :	square, triangle, rectangle, circle.
	posttest:	circle, rectangle, triangle, square.
Identifying	pretest :	triangle, rectangle, circle, square.
	posttest:	rectangle, triangle, square, circle.

Matching Shapes

For each group and for each inventory, more than 95 °/o of the children were able to match all 4 shapes; in fact, only 1 in Chula Vista matched correctly less than 2 of the 4 shapes in either pretest or posttest, and only 1 child in all other kindergarten classes could not match all 4 shapes (this child missed only 1 shape). On this basis, the task must be regarded as lacking in discrimination.

Geometry certainly occupies a prominent position in the contemporary elementary mathematics curriculum, so it is pertinent to assess and try to prognosticate a child's performance in this aspect. In view of the demonstrated ability of the children in our sample to match geometric shapes, it would be pointless to prognosticate posttest scores for this same task. However, initial results of Matching Shapes were considered here in order to determine their contribution to predicting success for the other two geometric tasks: Naming Shapes and Identifying Shapes. These effects will be reported later in our discussions for Naming Shapes and Identifying shapes as dependent variables.

Naming Shapes

As was in the case of color inventory, of the three tasks, matching, naming, and identifying, with reference to geometric shapes, the task considered most difficult was naming. This may be verified by the distribution for the initial inventory.

Table 8

GEOMETRIC SHAPES: INITIAL INVENTORY FREQUENCIES

Number Correct	Kindergarten			First Grade	
	Matching	Naming	Identifying	Naming	Identifying
0	4	61	24	40	16
1	4	68	28	92	46
2	27	62	84	128	103
3	26	42	47	126	86
4	207	14	84	68	206
Totals	268	247	267	454	457

In Table 9 below, the mean scores for Naming Shapes are presented, showing changes between initial and final inventories.

Table 9

NAMING SHAPES: MEAN SCORES

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Experimental	1.691	2.852	2.224	2.6745
Comparison	1.265	2.154	2.055	2.097

Clearly both experimental and comparison groups showed appreciable gains in kindergarten and some gains in first grade. However, as mentioned earlier in this report, gains cannot be cited from raw data alone since the two groups (experimental and comparison) did not share the same baseline.

The following variables in the pretest were proposed for examination with regard to their possible contribution in the regression for the predicted value of Naming Shapes:

visual memory (objects), visual memory (pictures), naming colors, identifying colors, matching shapes, naming shapes, identifying shapes, vocabulary, ordering, and classifying.

By stepwise regression, the variables matching shapes and ordering were deleted on the basis that their effects on the regression were negligible. Here, it should be mentioned that while visual memory (pictures) ranked high with respect to its weight on the regression, its correlation with Naming Shapes was negative. No causal relationship is intended to be inferred from this remark. The results might have been a reflection more of attitude toward the testing procedure for each respective assessment or a reflection of the understanding of given directions in each subtest than of the skill that the subtest proposed to measure.

The inclusion of the results for Classifying as a factor in the regression also warrants comments. Since the classifying task depended heavily upon ability to differentiate geometric shapes (as well as size and color), high correlation might be expected between Naming Shapes and Classifying. Due to the nature of these two items, one should not conclude from these test results that Classifying is a reliable index for performance in Naming Shapes. For Classifying, as for Visual Memory (Pictures), no causal relationship should be read into the data.

The treatment means for Naming Shapes in the posttests were adjusted by considering the regression on:

naming shapes, classifying, identifying colors, visual memory (pictures), identifying shapes, visual memory (objects), vocabulary, and naming colors.

For the kindergarten, these adjusted means were:

experimental: 2.711

comparison: 2.340 .

The variance ratio was: $F(1, 41) = 1.863$. With critical value in the 0.05 level equal to 4.08 , no significant difference was found between the two means after adjusting with the covariates.

In the regression for Naming Shapes for the first grade, the same treatment was applied, using the variables:

writing number symbols, naming colors, visual memory (pictures), identifying shapes, classifying, visual memory (objects), identifying colors, and vocabulary.

The adjusted means and F-ratio turned out to be:

experimental 2.703
comparison 2.042
$F(1, 54) = 11.620$;

critical value (0.01 level) = 7.08 .

Therefore, the difference between adjusted means for Naming Shapes in the first grade treatment groups was found to be significant in the 0.01 level. Moreover, with critical value for $F(1, 60) = 11.97$ in the 0.001 level, we see that our difference approached the 0.001 level of significance.

Identifying Shapes

The task for Identifying Shapes made use of the same shapes as for Naming. In this part of the assessment of geometric shapes, each time a name was supplied by the tester, the child was to show, by touching, the shape that was named. The mean scores for the four groups, kindergarten-experimental, kindergarten-comparison, first grade-experimental, and first grade-comparison, are given in Table 10 below.

Table 10

IDENTIFYING SHAPES: MEAN SCORES

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Experimental	2.466	2.585	3.007	2.905
Comparison	2.301	2.555	3.019	2.310

From this table, gains can be observed in the kindergarten population in both experimental and comparison groups. Whether the differences in the gains were significant were tested by the F-ratio after adjusting the criterion variable to contributing factors. In identifying the contributing factors, the possible candidates proposed were pretest scores for:

naming colors, identifying colors, visual memory (objects), visual memory (pictures), vocabulary, matching shapes, naming shapes, identifying shapes, ordering, and classifying.

Factors that were shown to be not significant for both experimental and comparison groups were: vocabulary, ordering, and visual memory (objects). Adjusting to the remaining variables, we obtained for means,

experimental 2.563
comparison 2.585
$F(1, 42) = 0.004$.

Since the critical value even at the 0.05 level is 4.08 , no significant difference was found for these two groups in Identifying Shapes in kindergarten.

Using the same list of variables as for kindergarten as potential contributive factors, the variables that were ultimately identified as being significant in the regression for Identifying Shapes in the first grade were:

naming shapes, classifying, identifying shapes, identifying colors, vocabulary, visual memory (pictures), and naming colors.

Adjusting with these covariates, we obtained the following means and variance ratio:

experimental 2.888
comparison 2.342
$F(1, 55) = 6.979$;
critical value (0.05 level) = 4.08 .

Therefore, the difference between adjusted means for Identifying Shapes was found to be significant in the 0.05 level for these two first grade groups.

Number Symbols[7]

Assessment for Number Symbols was separated into two tasks: Writing Number Symbols and Identifying Number Symbols. In the first grade posttest, an additional task, Naming Number Symbols was given. In this discussion, the assessments, Identifying Number Symbols, Writing Number Symbols, and Naming Number Symbols will be discussed separately.

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7. For specific instructions, see page

Identifying Number Symbols

In the subtest for identifying number symbols, numerals were printed (in handscript form) on sealed envelopes containing prescribed numbers of counting discs which were referred to as buttons. The envelopes were randomly placed on the table and the child was asked to hand the tester the envelope with a specified number of discs (buttons). This assessment was given to all kindergarten and first grade groups. In all forms of the kindergarten initial and final inventories, the assessment was identical in directions and in all 8 numerals involved. In the initial inventory for the first grade, 12 numerals were involved, including 3 in the teens; in the final inventory were 10 numerals, 4 of which were beyond the teens. So, while the same score in the pretests and posttests for the kindergarten might be considered to mean approximately the same level of accomplishment was attained, this might not be the case for the first grade since both number of items and level of difficulty have been changed from pretest to posttest. The numerals and their order in which they were presented are listed below; the numeral "2" was omitted from scoring because it was used to demonstrate the procedure for the child's response.

Kindergarten	Pretest and Posttest:	3, 1, 4, 5, 0, 8, 7, 9
First Grade	Pretest:	3, 1, 4, 5, 0, 8, 7, 9, 14, 6, 11, 17
	Posttest:	7, 9, 11, 26, 8, 16, 62, 27, 30, 51 .

In Table 11, the results for Identifying Number Symbols are presented.

Table 11

IDENTIFYING NUMBER SYMBOLS

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	272	193	462	388
Mean	4.007	6.176	9.271	8.724
Sigma	2.274	2.226	3.460	2.440
Range: Min. - Max.	0 - 7	0 - 8	0 - 12	0 - 10
Maximum Possible	8	8	12	10

For the kindergarten children, a substantial gain can be noted from the above table. In reading the data for the first grade, it is well to repeat the reminder that the tasks differed between initial and final inventories both with regard to the possible scores and with respect to levels of difficulty. In a gross fashion, the initial mean of 9.271 represented approximately 77 °/o of the numerals involved, while the final mean of 8.724 represented approximately 87 °/o of the numerals. Even greater caution must attend the interpretation since the tasks could not be considered comparable between pretest and posttest.

Because the treatment groups do not have comparable baselines, regressions for Identifying Number Symbols were obtained for experimental and comparison groups in each grade, kindergarten and first. Variables entered as possible influences to the regressions were initial scores for:

> identifying colors, visual memory (objects), visual memory (pictures), naming shapes, identifying shapes, vocabulary, identifying number symbols, counting (objects), counting (pictures), ordering, and classifying.

Of these, vocabulary and ordering were found to be negligible as covariates. Adjusting to the remaining variables as covariates, the following results were obtained:

experimental mean 6.311
comparison mean 5.512
$F(1, 40) = 4.305$

critical value (0.05 level) = 4.08 ,
(0.01 level) = 7.31 .

Therefore, there is significant difference between adjusted means for Identifying Number Symbols in favor of the experimental group at the 0.05 level but not at the 0.01 level.

The same variables were proposed for the regressions in the first grade. The variables found to be negligible here were: naming shapes, writing number symbols. The following results were obtained:

experimental mean 8.585
comparison mean 8.879
$F(1, 53) = 0.592$

critical value (0.05 level) = 4.08 .

Therefore no significant difference was found between adjusted means for Identifying Number Symbols in the first grade groups.

Writing Number Symbols

The task for Writing Number Symbols was given in conjunction with the one for counting objects. At the conclusion of each counting, the child was asked to write, if he was able, the numeral labeling the number of objects that he had just counted. The same seven numbers were used in the initial and final inventories for kindergarten and in the initial inventory for the first grade. The final assessment in the first grade extended the task to nine numbers, only one of which was less than ten. Number symbols involved for each assessment were:

Kindergarten	Pretests and posttests:	3, 5, 4, 6, 8, 7, 9
First Grade	Pretest:	3, 5, 4, 6, 8, 7, 9
	Posttest:	16, 5, 30, 23, 18, 32, 27, 50, 52.

The following table shows a comparison in performance between kindergarten and first grade on Writing Number Symbols. Note that on the pretest, the median score for the kindergarten group was 0 . This was to be expected: on entering kindergarten, at least half of the children do not know how to write a single numeral.

Table 12

WRITING NUMBER SYMBOLS

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	194	193	437	388
Mean	1.356	3.503	4.243	5.992
Sigma	1.919	2.428	2.160	3.064
Range: Min. - Max.	0 - 7	0 - 7	0 - 7	0 - 9
Maximum Possible	7	7	7	9

While the median for the entire kindergarten population was 0.000 , it is interesting to note that in the center for which we had the most

complete data on the experimental and comparison classes, the mean for the experimental class was 1.771 and median 0.545. Corresponding statistics for this center's comparison group showed a mean of 1.207 and a median of 0.000. Thus, in this center, the experimental classes consisted of children who apparently had more experience with writing number symbols than those in the comparison classes. The final inventory for these two groups showed an experimental mean of 3.870 and median of 4.375; comparison mean was 3.104 and median 2.692. These results are summarized below in Table 13.

Table 13

WRITING NUMBER SYMBOLS: KINDERGARTEN

	Experimental		Comparison	
	Initial	Final	Initial	Final
Sample N	48	39	82	92
Mean	1.771	3.870	1.207	3.104
Median	0.545	4.375	0.000	2.692
Sigma	1.992	2.512	1.864	2.311
Range: Min. - Max.	0 - 6	0 - 7	0 - 7	0 - 7
Maximum Possible	7	7	7	7

Substantial gains can be observed in both groups. To determine whether these groups differed significantly, regressions were obtained with the pretest variables:

> identifying colors, identifying shapes, visual memory (objects), visual memory (pictures), vocabulary, counting (objects), counting (pictures), identifying number symbols, writing number symbols, ordering, and classifying

as potential factors. Of these, ordering and classifying were rejected in stepwise regression as being of little significance. Adjusting to the remaining covariates, the means and variance ratio were:

> experimental 3.914
>
> comparison 3.047

$F(1, 43) = 4.212$

critical value (0.05 level) = 4.08 .

Hence, the difference between kindergarten treatment groups for Writing Number Symbols was significant in the 0.05 level but not in the 0.01 level.

The means for the first grade experimental and comparison groups in Writing Number Symbols were adjusted with the same covariates:

> writing number symbols, counting (pictures), identifying number symbols, counting (objects), identifying shapes, visual memory (objects), visual memory (pictures), vocabulary, and identifying colors.

The resulting adjustments yielded the following means and F-ratio:

experimental 5.764
comparison 5.875
$F(1, 53) = 0.049$
critical value (0.05 level) = 4.08 .

Therefore, no significant difference was found for Writing Number Symbols in the first grade between the adjusted means of the two treatment groups.

Naming Number Symbols

In the final inventory for the first grade, an assessment was made on the child's ability to name number symbols. Here, various numeral cards (twelve in all) were shown to the child in a prescribed sequence and the child was asked to name the numbers represented. The numbers required to be named and the order of presentation were as follows:

8, 11, 9, 16, 19, 14, 40, 23, 38, 41, 32, 80 .

The experimental group achieved a mean score of 9.334 with a sigma of 3.592 while the comparison group obtained a mean of 9.688 with a sigma of 3.230. Hence, there was apparently little difference in performance between the two treatment groups. However, the distribution for the entire population, which agreed characteristically with the distribution for each of the treatment groups, gave evidence of a weakness in this assessment. Approximately 52 °/o of the children named correctly all 12 symbols, and approximately 63 °/o named at least 11 of the 12 .

A regression with Naming Number Symbols as criterion variable was obtained, using the following variables as covariates:

identifying number symbols, counting (pictures), counting (objects), ordering, vocabulary, visual memory (pictures), visual memory (objects), identifying shapes, and naming colors.

Adjusting the means with these covariates, we obtained:

experimental 9.223
comparison 9.932
$F(1, 53) = 1.796$
critical value (0.05 level) = 4.08 .

Therefore, no significant difference was found between the means for Naming Number Symbols in the first grade groups after these means were adjusted with the covariates.

Counting[8]

Counting tasks were administered on three different levels: by dealing with manipulable objects (buttons), by representation of objects on picture cards, and by rote (cardinal counting). Each of these tasks was given to all centers and in every test form with the exception that object-counting was deleted from the first grade posttest. In lieu of this, rote counting by tens and tasks aimed at assessing the concept of place-value in numeration were introduced for this group in the final inventory.

Counting (Objects)

In the subtest using manipulable objects, buttons were heaped in front of the child, and the child was asked to count out specified numbers of buttons into various boxes. In every form of the test which included this task, the instructions and sequence of numbers required for counting were identical. The order in which the numbers were given was:

3, 5, 4, 6, 8, 9 .

Counting (objects) was one of the covariates appearing in the regressions for a variety of criterion variables. In both kindergarten and first grade, it appeared in the regressions for:

identifying number symbols, writing number symbols, counting (pictures), and ordinal numbers.

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8. For specific instructions, see page 58.

The adjusted means resulting from introducing Counting (Objects) and other variables as covariates are given in the corresponding section for the independent variable.

Since in both experimental and comparison groups, more than half of the population was able to attain maximum score (67 °/o in the experimental group, 53 °/o in the comparison group), it was not clear what scores might have been attained had the ceiling been higher. For this reason, no attempt was made to test the significance of the difference for this task; instead, we display here a table showing the actual results from the testing.

Table 14

COUNTING (OBJECTS)

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	270	196	462	
Mean	3.741	5.684	5.874	
Median	2.786	6.148	6.148	
Sigma	2.321	2.113	1.833	Not given in final inventory
Range: Min. - Max.	0 - 7	0 - 7	0 - 7	
Maximum Possible	7	7	7	

Counting (Pictures)

In this assessment, the child was shown eight picture cards, one at a time, on which were printed specific numbers of objects such as toys, balloons, people, and so on. The child was to identify the number of objects on each card. This procedure was identical for all groups and for every form of the individual assessments. The table below presents the means for the experimental and comparison groups in both kindergarten and first grade.

Table 15

COUNTING (PICTURES): MEAN SCORES

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Experimental	3.561	6.542	6.416	7.261
Comparison	3.711	5.392	5.250	7.427

Substantial gains can be noted in both kindergarten groups: the experimental group gained almost 3 points and the comparison group gained more than 1.5 points out of a possible 7 . Although both groups started at approximately the same level, the experimental group started out slightly lower. It can be seen too, that apparently the experimental group showed greater growth. To determine whether this observed growth was significantly different from that for the comparison group, means were adjusted by covariant technique, using

> counting (objects), identifying colors, counting (pictures), visual memory (objects), vocabulary, visual memory (pictures), identifying number symbols, writing number symbols, and identifying shapes

as covariates. The difference of the adjusted means was tested for significance by the F-ratio. Adjusted means and F-ratio are given below:

> experimental 6.373
> comparison 5.616
> $F(1, 40) = 4.647$
> critical value (0.05 level) = 4.08 .

Therefore, the difference of adjusted means for Counting (Pictures) was found to be significant in the 0.05 level, with the mean higher for the experimental kindergarten than for the corresponding comparison group.

The first grade groups were similarly treated, with the following variables identified as covariates in the regression:

> counting (objects), identifying number symbols, visual memory (objects), visual memory (pictures), and ordering.

The adjusted means and variance ratio were:

experimental 7.302
comparison 7.349
$F(1, 57) = 0.042$
critical value (0.05 level) = 4.08 .

Hence, no significance was found between the adjusted means for Counting (Pictures) in the first grade treatment groups.

Rote Counting

Attempts were made to assess the ability to count by rote in kindergarten and in the first grade. The child was asked to count, and if he did not respond, he was given a start: "One, two." In this assessment, scoring was particularly difficult especially if the child skipped around, or, in many instances, started from one (or some other previously counted number) again when he floundered in counting. Often, such fresh starts did take the child beyond the point the looping began. Thus, a question in scoring was expected, and testers were instructed to mark the last number counted without error, and the last number counted with one error by different markings.

Rote counting by ones was scored on a scale with a score of 0 for the last number counted being any number from 0 through 9 ; 1 for the last number being any number from 10 through 19 ; and so on; finally, 8 for any number from 80 through 100 .. In the first grade posttest, a similar assessment was made for counting by tens. In the scoring here, the scale ranged from 0 through 20 to represent terminal points at 0 through 200 in intervals of tens.

Because of many inherent difficulties in the attempt to measure Rote Counting, the comments provided by the testers gave a much more accurate picture of what occurred during testing. However, these comments were mostly subjective opinions. We display below, vague results of the rote counting on the scale indicated above without serious attempt at analyzing these results. Because of the peculiarity in the scale, a mean score of 1.372 (kindergarten, initial) very roughly indicates an average of counting up to the teens: somewhere between 10 and 20 .

Table 16

ROTE COUNTING BY ONES

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	266	194	461	390
Mean	1.372	2.747	2.748	5.549
Median	0.587	1.630	1.553	7.020
Sigma	1.454	2.229	2.292	2.750
Range: Min. - Max.	0 - 8	0 - 8	0 - 8	0 - 8
Maximum Possible	8	8	8	8

For rote counting by tens (first grade posttest), a mean of 9.558 and a median of 9.291 were achieved with sigma equal to 4.266. About 7 °/o of the children in this group were able to count by tens to 200, at which point, the counting was stopped. The rough estimate for the rote counting by tens as indicated here is that, on the average, by the end of the first grade, these children could count by tens up to 90 or 100 .

Place Value[9]

Closely associated with the counting tasks described in the previous section were those items on concept of place-value. Two levels of the concept were assessed: the ability to name numbers of objects involving place-value in the numeration, and the ability to construct representations (bundles of objects) of specified numbers of objects when the numbers involved place-value in the numeration. The objects used were paste sticks. Numbers involved and the order of presentation were:

Naming: 20, 50, 60, 30, 35, 57, 24, 47, 19, 75

Forming: 16, 5, 30, 23, 18, 32, 27, 50, 42 .

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9. For specific instructions, see page 59.

These assessments were given only to the first grade at the end of the year. The results of these assessments, given only once, are displayed in Table 17 below.

Table 17

PLACE VALUE: NAMING AND FORMING

	Naming	Forming
Sample N	383	376
Mean	4.324	3.824
Median	3.069	1.412
Sigma	4.192	3.669
Range: Min. - Max.	0 - 10	0 - 9
Maximum Possible	10	9

The experimental and comparison groups performed almost identically in Naming Place Value, the means differing only by 0.159, with both sigmas being close to 4 . In Forming Place Value, the two groups were also comparable in performance. A more revealing indication of the performance was shown in the abnormal distribution for these two tasks. This is illustrated below by the frequency counts which accounts quite well for a mean of 4.324 and a sigma of 4.192 for Naming and a mean of 3.824 and sigma of 3.669 for Forming.

Table 18

PLACE VALUE NAMING AND FORMING: FREQUENCY COUNTS

Number Correct	0	1	2	3	4	5	6	7	8	9	10	total
Naming	132	34	10	13	36	8	10	88	18	21	93	383
Forming	74	100	34	17	8	4	13	11	23	92		376

Ordinal Numbers[10]

Assessment was made for the children's understanding of the ordinal numbers, first through fifth. Included in the assessment was the closely associated word "last". An inspection of the test directions will give indication that this inclusion was made for more than the reason that there was a close association of ideas with the ordinal numbers in the word, last. By incorporating with other items in the assessment, it might be possible then to determine the child's reference point from which he started his count: first, second, third, ...

Ordinal Numbers was given in two parts, each part consisting of eight items. The assessment was identical in both the kindergarten and first grade posttests; it was not included in the kindergarten pretest, but was given in the initial inventory for the first grade with the numbers in a slightly different sequence from the posttest. The order of numbers was as follows:

Part 1 Pretest: first, fourth, third, fifth, first, last, second, fourth.

Posttest: first, third, fifth, fourth, first, last, second, fourth.

Part 2 Pretest: second, fifth, fourth, second, last, first, third, fifth.

Posttest: third, fifth, fourth, second, last, third, first, fifth.

Table 19 below gives the means for pretests and posttests in Ordinal Numbers. Note that in the first grade, both experimental and comparison classes showed evidence of growth: the experimental group gained about 2.5 points and the comparison group gained about 3.3 points.

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10. For specific instructions, see page 61.

Table 19

ORDINAL NUMBERS: MEAN SCORES

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Experimental	Not given	7.711	11.032	13.182
Comparison	Not given	8.484	10.900	14.366

To determine whether there was significant difference in the two groups, experimental and comparison, covariant technique was applied obtaining adjusted means for test of significance. The same treatment was applied to the kindergarten data even though no initial inventory was given, hence, no growth could have been observed. Regression here equally well obtained on the basis of correlation between the covariates and Ordinal Numbers as dependent variable.

For the kindergarten, the variables selected as significant factors for the regression were:

counting (objects), naming colors, visual memory (pictures), vocabulary, counting (pictures), writing number symbols, and identifying number symbols.

This regression yielded the following adjusted means and variance ratio:

experimental 8.016
comparison 8.081
$F(1, 42) = 0.003$
critical value (0.05 level) = 4.08 .

Therefore, no significance was found for the difference between adjusted means for Ordinal Numbers in the kindergarten groups.

By stepwise regression, the following variables were selected as covariates for Ordinal Numbers as criterion variable in the first grade:

identifying number symbols, counting (pictures), visual memory (objects), counting (objects), writing number symbols, naming colors, visual memory (pictures), and vocabulary.

The results of this adjustment are displayed below:

experimental mean 13.331
comparison mean 14.081
$F(1, 54)$ = 2.312
critical value (0.05 level) = 4.08 .

Therefore, no significance was found for the difference between adjusted means for Ordinal Numbers in the first grade classes.

Pairing[11]

The assessment on Pairing was given only to the first grade classes and only in the final inventory. Here, the child was given a sheet of paper folded into four pages. On each page were two sets of drawings separated by a line drawn down the middle of the page. The child was to pair an object in one set with an object in the other set in a one-to-one manner. The experimental group had a mean score of 3.366 out of 4 with a sigma of 1.201 and the comparison group had a mean of 2.759 with a sigma of 1.547. So it appeared that the experimental group performed better, and with tighter clustering about the mean. A test of significance seemed to be suggested here. However, the abnormal distribution as shown by the frequency counts for the entire population speaks against pursuing this avenue, since almost 71 % of the children attained maximum score.

Table 20

PAIRING: FREQUENCY COUNTS

Number Correct	0	1	2	3	4	total
Frequency	36	15	13	43	258	365

This same skewed characteristic was also evident in the frequencies for the classes split into experimental-comparison groupings. The shallowness of the ceiling in this task apparently indicated weakness of this item in being able to discriminate.

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11. For specific instructions, see page 62.

Equivalent Sets[12]

In the assessment for Equivalent Sets, the child was presented six cards in sequence and was asked to construct a set (using buttons) equivalent to a set of objects shown on the card. Detailed comments were asked of the testers in the attempt to obtain clues as to the process by which the child performed this task: by copying the pattern of the printed picture, by counting the objects in the drawing, or by other means (explicitly stated by the tester). This task was given to both kindergarten and first grade groups, but only as a posttest item. Thus, no measure of growth was made for this ability. The performance on this task is shown by the table displayed below.

Table 21

EQUIVALENT SETS

	Kindergarten	First Grade
Sample N	193	389
Mean	4.176	5.319
Median	4.394	5.196
Sigma	2.067	1.238
Range: Min. - Max.	0 - 6	0 - 6
Maximum Possible	6	6

Apparently there is a difference in performance between the kindergarten and first grade groups. However, frequency counts showed about 35 °/o of the children in kindergarten attained a maximum score of 6 , and 60 °/o got a score of at least 5 . A more severe skewing was shown for the first grade: about 62 °/o made a score of 6 , and more than 87 °/o made either 5 or 6 . Evidently the effectiveness of this item as a valid measure is questionable.

Split into experimental and comparison groups, the kindergarten experimental classes achieved a mean of 4.263 with a sigma of 2.177, and

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12. For specific instructions, see page 63.

the comparison classes had a mean of 3.826 with a sigma of 2.187. Thus, the experimental and comparison groups performed approximately equally for Equivalent Sets. The same kind of comparability may be observed between the experimental and comparison groups in first grade: experimental mean was 5.208 and sigma 1.439; comparison mean was 5.362 and sigma 1.217.

Vocabulary[13]

Assessment was made on some of the vocabulary used in the mathematics program for kindergarten and first grade. This task was given in both pretests and posttests for kindergarten except for the initial inventory in Chula Vista. Here, in lieu of Vocabulary, an assessment on Visual Recognition was presented. Vocabulary was also included in the first grade test, but only in the initial inventory. The vocabulary assessed was identical in both kindergarten pretests and posttests; only slight changes were made in the order in which the items were presented:

> behind, above, on, between, each, remove, set, more than, as many as, fewer than, join, below, left, outside, inside, on, right.

Assessment for the first grade was the same with the exception that the words "left" and "right" were not included in the first grade testing. In reading the data reproduced below, the difference in scales between kindergarten and first grade should be kept in mind. Thus, the initial mean in kindergarten of 12.283 represented approximately 72 °/o of the 17 subitems, and the initial mean of 11.522 in the first grade represented approximately 77 °/o of the 15 subitems.

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13. For specific instructions, see page 64.

Table 22

VOCABULARY

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	269	194	462	Not given in final inventory
Mean	12.283	12.378	11.522	
Median	11.965	12.148	11.527	
Range: Min. - Max.	5 - 17	4 - 16	2 - 15	
Maximum Possible	17	16	15	

Note that there was also a change in scale between the pretest and posttest in kindergarten. In the pretest, two assessments were made for the word "on"; in the posttest, one of the items was deleted. Thus, the final mean of 12.378 for kindergarten did not appear to be much different from the initial 12.283. However, the final mean represented approximately 77 °/o of the items as against the initial 72 °/o.

The difference in performance between experimental and comparison groups may be seen in Table 23.

Table 23

VOCABULARY: EXPERIMENTAL-COMPARISON

	Experimental		Comparison	
	Initial	Final	Initial	Final
Mean	12.103	13.247	12.430	11.233
Sigma	2.345	2.114	1.848	2.507

To test for significance in difference between these two groups on this assessment, the following variables were proposed as possible co-variates:

naming colors, identifying colors, visual memory (objects), visual memory (pictures), matching shapes, identifying shapes, naming shapes, ordering, classifying, and vocabulary.

From this list, seven were retained on the basis that they were found to contribute significantly in the regression. These were:

naming colors, identifying shapes, visual memory (pictures), matching shapes, vocabulary, naming shapes, and identifying colors.

With these as covariates, the adjusted means and F-ratio were:

experimental 12.984
comparison 11.580
$F(1, 42) = 7.29$
critical value[14] (0.01 level) ≈ 7.27 .

On this basis, the difference between adjusted means for Vocabulary as criterion variable was found significant in the 0.01 level for the kindergarten groups. No regression was obtained for Vocabulary in the first grade since this assessment was not given in the posttest for this grade.

Ordering and Classifying[15]

Assessment was attempted for Ordering, Classifying, and Ordering-Classifying. Here, the child was presented with various situations involving geometric shapes in a variety of sizes and colors. For Ordering, the child might be required to pick out the largest or smallest of specified shapes, or to arrange sets of shapes in order: smallest-largest or largest-smallest. For Classifying, the task might have consisted of classifying along a single dimension (for example, picking out all shapes that are red), or more than one dimension (for example, picking out all red triangles). There were also a small number of items involving both Ordering and Classifying such as: the smallest of each shape. It was expected that

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14. Fisher and Yates tables (Statistical Tables for Biological, Agricultural and Medical Research, Oliver and Boyd, Ltd., Edinburgh) showed the critical value for $F(1, 40)$ to be 7.31; the approximation given here was obtained by curvilinear interpolation from these tables.

15. For specific instructions, see page 67.

much information might be elicited from such tasks. Thus, a large investment in testing time was made for this section of the testing. However, there was evidence of confusion to the child, to the tester, or to both as noted by many comments accompanying no attempt at scoring.

The variables were included as potential covariates for every stepwise regression considered. Ordering appeared as a variable three times in the end (Naming Number Symbols, Identifying Number Symbols, and Counting Pictures); Classifying was selected twice (Naming Shapes, Identifying Shapes); and Ordering-Classifying was never selected. It might have been that for all the time consumed, the scoring was limited in extent and in depth. In a test situation as we experienced, it might be that one did not have the luxury of probing in depth what the results of ordering and classifying might mean. Our aim to assess, but at the same time to keep the probing within the attention span of the children, was apparently diametrical in thought. We display below merely the raw results of these assessments without further comments.

Table 24

ORDERING

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	271	189	463	389
Mean	2.151	3.439	2.551	4.265
Median	1.601	2.986	2.084	3.868
Sigma	1.087	1.619	1.334	1.085
Range: Min. - Max.	0 - 4	0 - 7	0 - 4	0 - 7
Maximum Possible	4	7	4	7

Table 25

CLASSIFYING

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	270	189	456	389
Mean	1.300	3.016	1.257	3.982
Median	0.945	2.449	0.968	3.485
Sigma	0.758	1.435	0.813	1.406
Range: Min. - Max.	0 - 2	0 - 6	0 - 2	0 - 6
Maximum Possible	2	6	2	6

Table 26

ORDERING - CLASSIFYING

	Kindergarten		First Grade	
	Initial	Final	Initial	Final
Sample N	261	189	463	389
Mean	0.487	2.788	2.629	3.635
Median	0.000	2.319	2.100	3.221
Sigma	0.501	1.344	1.431	1.508
Range: Min. - Max.	0 - 1	0 - 6	0 - 5	0 - 6
Maximum Possible	1	6	5	6

SUMMARY

The tables reproduced in the following two pages present items which were each considered separately as a dependent variable in a regression with other variables entering as covariates. Seven such dependent variables were examined for the kindergarten groups and the same number for the first grade. Six of the seven items bore the same identifying labels for kindergarten and first grade, although the specific tasks were not always identical. These common entries were:

> naming shapes, identifying shapes, writing number symbols, identifying number symbols, counting (pictures), and ordinal numbers.

The seventh dependent variable for kindergarten was "Vocabulary", an item that did not appear in the first grade posttest. For the first grade, the seventh dependent variable was "Naming Number Symbols", an item that was not included in the kindergarten posttest. The mark x appears in these tables for covariates contributing to the regression.

Table 27

COVARIATES FOR DEPENDENT VARIABLES: KINDERGARTEN

Covariate	Dependent Variable: Naming Shapes	Identifying Shapes	Writing Number Symbols	Identifying Number Symbols	Counting (Pictures)	Ordinal Numbers	Vocabulary
Visual Memory (Objects)		x	x	x	x		
Visual Memory (Pictures)	x	x	x	x	x	x	x
Naming Colors	x	x				x	x
Identifying Colors	x	x	x	x	x		x
Matching Shapes	x						x
Naming Shapes	x	x		x			x
Identifying Shapes	x	x	x	x	x		x
Writing Number Symbols			x	x	x	x	
Identifying Number Symbols			x	x	x	x	
Counting (Objects)			x	x	x	x	
Counting (Pictures)			x	x	x	x	
Vocabulary		x	x		x	x	x
Classifying	x	x					

Table 28

COVARIATES FOR DEPENDENT VARIABLES: FIRST GRADE

Covariate	Dependent Variable: Naming Shapes	Identifying Shapes	Writing Number Symbols	Naming Number Symbols	Identifying Number Symbols	Counting (Pictures)	Ordinal Numbers
Visual Memory (Objects)	x		x	x	x	x	x
Visual Memory (Pictures)	x	x	x	x	x	x	x
Naming Colors	x	x		x			x
Identifying Colors	x	x	x		x		
Naming Shapes		x			x		
Identifying Shapes	x	x	x	x	x		
Writing Number Symbols	x		x		x		x
Identifying Number Symbols			x	x	x	x	x
Counting (Objects)			x	x		x	x
Counting (Pictures)			x	x			x
Ordering				x	x	x	
Vocabulary	x	x	x	x	x		x
Classifying	x	x					

The tables presented in the preceding pages show that for the battery of tests used in our study, Visual Memory, particularly the assessment having to do with pictures on printed pages, contributes to most of the treatment variables. This apparently supported the conjecture that visual memory generally plays an important role in ability to perform well in learning tasks. On the other hand, Ordering and Classifying, two tasks that frequently have been considered by many researchers to be important to the learning process, appeared to be overrated for our study at hand: Classifying entered as covariate in only two of the seven variables for the kindergarten or first grade, and Ordering did not qualify for any in kindergarten but for three regressions in the first grade. Whether these circumstances truly indicate conflict between our findings and those appearing in other literatures cannot be determined without careful investigation here. The weakness might well be in the structure of the items in our tests. We note, for example, interitem reliabilities (Appendix C) for Ordering, Classifying, and Ordering-Classifying were quite low. Aside from low interitem reliabilities, another explanation for apparent departure from other findings might lie in whether our items do indeed measure abilities to order or to classify. Again, careful investigation would be required before such matters can be settled.

In order to obtain a perspective on some of the findings as reported in the foregoing pages, a summary is given in tabular form below, showing the adjusted means and the significance level if such were attained.

Table 29

ADJUSTED MEANS FOR SELECTED VARIABLES

Assessment	Kindergarten			First Grade		
	Exp.	Comp.	Level	Exp.	Comp.	Level
Naming Shapes	2.711	2.340	n.s.	2.703	2.042	0.01
Identifying Shapes	2.563	2.585	n.s.	2.888	2.342	0.05
Writing Number Symbols	3.914	3.047	0.05	5.764	5.875	n.s.
Naming Number Symbols				9.223	9.932	n.s.
Identifying Number Symbols	6.311	5.512	0.05	8.585	8.879	n.s.
Counting (Pictures)	6.373	5.616	0.05	7.302	7.349	n.s.
Ordinal Numbers	8.016	8.081	n.s.	13.331	14.081	n.s.
Vocabulary	12.984	11.580	0.01			

On the assumption that the assessments had been appropriately categorized by the labels given, we note that in the kindergarten groups, the difference between adjusted means was identified as being significant in four instances out of seven. These four instances were:

Vocabulary, at the 0.01 level, and

Counting (Pictures), Identifying Number symbols, Writing Number Symbols, each at the 0.05 level.

Although none of the differences attained the 0.001 level of significance, of particular interest was the observation that whenever significance of difference was found, the adjusted mean was higher for the experimental group than for the comparison group.

In the first grade, only two of the seven differences between adjusted means were found to be significant. These were both related to geometric shapes: Naming Shapes, within 0.01 level (almost 0.001 level); and Identifying Shapes, within the 0.05 level. Again, as in the kindergarten groups, whenever significance in the difference occurred, the experimental group using the SMSG curriculum had the higher adjusted mean.

APPENDIX A

Sequence of Test Items

As was mentioned in our discussion about the testing program (page 4), there was concern as to whether the order of presenting the items might significantly influence the results. To get an idea as to whether this concern might be justified, the kindergarten test was administered in two forms in the large centers, Oakland and Washington. The table below shows the order of appearance of the items in each form. It can be seen that the second form differed from the first simply in that the second half of the test was given first.

Table 30

SEQUENCE OF ITEMS: FORMS A AND B

Form A	Form B
Naming Colors	Matching Shapes
Identifying Colors	Naming Shapes
Counting (Objects)	Identifying Shapes
Writing Number Symbols	Counting (Pictures)
Ordering and Classifying	Rote Cardinal Counting
Identifying Number Symbols	Visual Memory (Pictures)
Visual Memory (Objects)	Vocabulary
Matching Shapes	Naming Colors
Naming Shapes	Identifying Colors
Identifying Shapes	Counting (Objects)
Counting (Pictures)	Writing Number Symbols
Rote Cardinal Counting	Ordering and Classifying
Visual Memory (Pictures)	Identifying Number Symbols
Vocabulary	Visual Memory (Objects)

The testers were instructed to alternate the two forms in the testing in order that approximately the same number of children would be taking each form. To facilitate this alternation, the test forms issued to the testers had the forms prearranged in this fashion.

From the table below, we can observe that the numbers (N) of tests given for the two forms were approximately equal. The slight preference for the number of Forms A might have been accounted for by the way the forms were counted out for each tester.

This table presents the mean and t-value of each item, with an appropriate notation if the difference between sample means attained significance. For each pair of numbers in the entries, the first refers to the entry for Form A , and the second to the same entry for Form B .

Table 31

DIFFERENCES BETWEEN SAMPLE MEANS: FORMS A AND B

Assessment	Sample Means	N	t	Significant Level
Naming Colors	5.063 , 5.278	142 , 126	-0.8142	n.s. ↘
Identifying Colors	4.589 , 4.654	141 , 127	-0.2705	n.s. ↘
Counting (Objects)	3.652 , 3.837	141 , 129	-0.5709	n.s. ↘
Writing Number Symbols	1.229 , 1.480	96 , 98	-0.9111	n.s. ↘
Ordering and Classifying	0.511 , 0.460	137 , 124	0.8213	n.s. ↗
Identifying Number Symbols	4.056 , 3.954	142 , 131	0.3684	n.s. ↗
Visual Memory (Objects)	3.437 , 3.558	142 , 129	-0.9438	n.s. ↘
Matching Shapes	3.719 , 3.465	139 , 129	2.4591	0.02 ↑
Naming Shapes	1.594 , 1.421	133 , 114	1.1378	n.s. ↗
Identifying Shapes	2.667 , 2.364	138 , 129	1.9474	n.s. ↗
Counting (Pictures)	4.290 , 3.391	138 , 128	2.5958	0.02 ↑
Rote Cardinal Counting	1.453 , 1.283	139 , 127	0.9614	n.s. ↗
Visual Memory (Pictures)	1.341 , 1.430	138 , 128	-0.6218	n.s. ↘
Vocabulary	12.388 , 12.140	139 , 129	0.9587	n.s. ↗

Note: The arrows in the right hand column have been included to serve as a graphical index of the trend and significance of the t-values at the 0.02 level. These arrows are meant to convey the following information:

↑ t positive, significant;
↗ t positive, not significant;
↘ t negative, not significant;
↓ t negative, significant.

The only differences between sample means for Forms A and B are those for Counting (Pictures) where the level of significance was between 0.01 and 0.02 ($0.01 < p < 0.02$), and for Matching Shapes where the level of significance was 0.02 ($p < 0.02$), both of these with t positive in favor of Form A. Identifying Shapes approached significance on the 0.05 level, but a more stringent requirement is preferred in line with our stated intention to lean on the conservative side of interpretation.

In general, it appeared that the order of presenting the items did not materially influence the scores. Where there were exceptions, we note that these occurred in the last half of Form A, and in its favor. We might conjecture that the child had learned more about how to respond to the tester by the last half of the testing session. The t's were almost all positive for items appearing in the second half of each test, and this would agree with the conjecture. However, the fact that the level of significance was not attained, and exceptions to the trend, speak against conclusions that cannot be substantiated without qualifications. We can state, nonetheless, that in our examination, no significant difference at the 0.02 level was observed between corresponding items in Forms A and B except for Matching Shapes and for Counting (Pictures).

APPENDIX B

Individual Inventories

GENERAL DIRECTIONS

SETTING FOR ADMINISTRATION OF TESTS

It is important to have a separate room, if at all possible, so that interruptions and distractions are minimized.

In introducing these tests to the child, make certain that they are always referred to as games and not as tests. The child will feel more comfortable if this is not presented as a testing situation and if the tester chats with the child to put him at ease before starting.

EQUIPMENT

You will need a table and two chairs. Preferably, the table and chairs should be low (from the kindergarten or first-grade classroom) so that they are a comfortable height for the child. Seat the child across the table from you.

The materials you will need are those supplied and include:

- 1 set geometric shapes
- 50 buttons
- 4 boxes with tops
- pads of paper
- crayons
- 1 set of 8 number cards for counting members
- 10 envelopes with buttons inside and numerals on them
- 1 set of 6 number cards for equivalent sets
- objects for visual memory (1 each): apple, banana, book, box, button, car, cat, chair, clock, cow, crayon, dime, dog, horse, key, nickel, orange, pencil, penny, rubberbands, string, truck
- 12 blocks
- 2 sheets of construction paper
- 5 trucks
- 25 marbles

7 sets for ordering and classifying
5 sets of pictures for visual memory
1 set of color cards

PROCEDURE

Read over the instructions for administering the tests several times, and become familiar with the materials before you start testing your children.

The instructions for you, as tester, are typed in lower case. What you actually say to the child is typed in capital letters.

Follow the written directions carefully. Do not probe to get an answer beyond what is suggested in the directions--this is an evaluation and should not be used as a teaching situation.

Use reassurance without specifying that responses are right or wrong. This may be done in a variety of ways:

Repeating what the child has said in a reassuring voice.
Remarks such as "Um - Humm", "All Right".
Comments between tests such as "You do these very well".
Conversation with the child between tests.

In order that the child not experience failure, certain tests are not to be continued if the child fails 2 consecutive tasks in that part of the test. This will be noted in the instructions for the specific tests. On some tests, such as ordering, you will continue the entire test whether the child misses 2 consecutive tasks or not.

Keep all equipment in a box under the table to your right. Place on the table only those items required for a given task, along with the instructions and score sheets for that particular task. Remove materials used for a task from the table before beginning the next part of the testing.

SCORING

The scoring sheets should be completely filled out.

Be certain to enter the child's name on each scoring sheet.

It is important to use the "Comments" space whenever relevant. These comments will be helpful in two ways.

(1) In following the progress of each child;

(2) In revising the tests.

In certain of the tasks, specific comments are requested (e.g., Ordering). Be certain to enter comments where specifically noted and at any points where they are relevant to understanding the child's response. If doubtful about the correctness of a response, do not check the response as correct or incorrect, but write down exactly what the child said in the "Comments" space.

IMPORTANT CONSIDERATIONS

In order for these test results to be meaningful:

(1) it is imperative that the tester adhere to the written directions as closely as possible. Rapport with the child is crucial; however, cueing the child beyond the written directions invalidates the results;

(2) it is imperative that recording of children's performance on the score sheet be as accurate as possible. Score sheets may be completed in pencil; overemphasis on neatness may be unnecessarily time-consuming. Entries should be legible and accurate; neatness is not a primary consideration;

(3) it is imperative that every subtest be completely recorded;

(4) it is imperative that the testing be scheduled so that you will finish testing the children assigned to you within the next few weeks.

SPECIFIC DIRECTIONS

VISUAL RECOGNITION

Administered only to Chula Vista kindergarten children.

Objects

I AM GOING TO SHOW YOU SOME THINGS. YOU TELL ME THE NAMES OF THE THINGS I SHOW YOU.

Show _____ . (Show objects in order listed on the scoring sheets.)

WHAT IS THIS?

If the child gives the incorrect name or more generic name, e.g., animal for horse, say:

WHAT ELSE COULD IT BE?

If still not the specific name, say:

IS IT LIKE SOMETHING ELSE YOU KNOW?

If still not the correct name, say:

DO YOU KNOW WHAT IT IS USED FOR?

Present objects in the order listed on the scoring sheet.

Pictures

THIS TIME I'M GOING TO SHOW YOU SOME DRAWINGS. YOU TELL ME WHAT THEY ARE.

Show _____. (Show drawings in order listed on the scoring sheets.)

WHAT IS THIS?

If the child gives the incorrect name, say:

WHAT ELSE COULD IT BE?

If still not the specific name, say:

IS IT LIKE SOMETHING ELSE YOU KNOW?

Present drawings in the order listed on the scoring sheet.

Scoring

The scoring for each of the above subtests for Visual Recognition was made on a chart in which a list of objects or pictures appeared in the first column. Three additional columns were provided: one to be checked if the response was correct, another if the response was incorrect, and finally, one column for entering pertinent comments.

VISUAL MEMORY

Administered to all centers. Visual Memory (Objects) did not appear in the initial inventory for the first grade.

Objects

NOW, WE WILL TRY A DIFFERENT GAME. I AM GOING TO PUT SOME THINGS ON THE TABLE. WATCH CAREFULLY.

Place the objects in a line, from left to right, on the table as listed. First trial use Group 1, second trial Group 2, and so on.

LOOK AT THEM VERY CAREFULLY.

Make sure the child attends to the objects.

I AM GOING TO TAKE ONE OF THESE AWAY (point to each object separately) WHILE YOU HAVE YOUR EYES CLOSED.

NOW CLOSE YOUR EYES AND KEEP THEM TIGHTLY CLOSED UNTIL I TELL YOU TO OPEN THEM.

Remove the underlined object from the table and place in box under table.

Close objects up so that spacing is even.

OPEN YOUR EYES. WHAT DID I TAKE AWAY?

If the child is correct, mark under First Recall on score sheet and proceed with next group. If no reply, or incorrect, then say:

WHAT ELSE WAS THERE BEFORE YOU CLOSED YOUR EYES THAT ISN'T THERE NOW?

Pause. If correct, mark under Second Recall on score sheet and proceed with next group. If no reply, or incorrect, then say:

DO YOU KNOW WHAT I TOOK AWAY?

If child is correct this time, mark under Third Recall and proceed with next group. If child cannot recall, then proceed as follows:

I'LL PUT SOME THINGS ON THE TABLE.

Move objects already on the table to the side and put new set on the table in line as listed. The object that was removed is underlined.

WHICH ONE OF THESE WAS ON THE TABLE BEFORE YOU CLOSED YOUR EYES?

If child cannot recognize the object included in the added set, tell and show him which object it was. Tell the child:

LET'S TRY ONE MORE GAME LIKE THIS.

Pictures

HERE ARE PICTURES OF SOME THINGS YOU KNOW.

Place Practice Set in front of the child.

LOOK AT EACH OF THESE PICTURES VERY CAREFULLY.

Make sure that the child attends to the pictures.

ON THE NEXT PAGE THE PICTURES ARE THE SAME, BUT ONE OF THESE (pointing to the pictures) WILL BE MISSING. YOU HAVE TO REMEMBER THE PICTURES ON THIS PAGE SO THAT YOU KNOW WHAT IS MISSING ON THE NEXT PAGE.

Make sure the child looks at both pictures. If child does not look at each picture, say:

LOOK AT EACH ONE.

Fold the page back under the next two pages. Since the paper is thin and pictures can be seen through from the page underneath that being shown to the child, place a clean sheet of paper between the one being shown and those underneath it.

ALL RIGHT, WHAT PICTURE IS MISSING FROM THIS PAGE THAT WAS ON THE PAGE YOU JUST LOOKED AT?

If the child is correct, mark under First Recall on score sheet, and proceed with Set I . If the child does not reply, or is incorrect, say:

WHAT ELSE WAS ON THE LAST PAGE THAT ISN'T ON THIS PAGE?

Pause. If correct, mark under Second Recall on score sheet, and proceed with Set I . If no reply, or incorrect, then say:

DO YOU KNOW WHAT IS MISSING?

If the child is correct this time, mark under Third Recall, and proceed with Set I . If child still cannot recall, then proceed as follows:

I'LL SHOW YOU SOME NEW PICTURES.

Turn to the third page of the Practice Set, showing the mouse and the train. Say:

WHICH ONE OF THESE WAS ON THE FIRST PAGE BUT NOT ON THE PICTURE I JUST SHOWED YOU?

If child cannot recognize the removed picture in the new set, tell and show him the train engine. Then tell the child:

LET'S TRY ANOTHER GAME LIKE THIS.

Proceed with the same directions through Set IV .

In scoring this test, if the child makes a mistake in vocabulary, such as calling the bird a duck or the engine a train, this is acceptable. However, be sure to note this in comments.

Scoring

Scoring for both Visual Memory (Objects) and Visual Memory (Pictures) was done in the same manner. The form reproduced below for Visual Memory (Pictures) is illustrative of the procedure used for checking each item. If

the child succeeded within the first three recalls, the appropriate column was checked and the test proceeded to the next "Original Set" or to the next task; the "New Set" was constructed only in the event that the child failed all three recalls. In the event a new set was required, the Correct or Incorrect column was checked accordingly.

Table 32

SCORING FOR VISUAL MEMORY (PICTURES)

Original Set	Removed Picture	Recalls 1st	2nd	3rd	New Set	Correct	Incorrect	Comments
Pr Engine Fish	Engine				Mouse Engine			
1 Book Car Bird Apple	Bird				Kite Bird Crayons Fish			
2 Cat Boat Tree Crayons	Boat				Boat Book Bottle Turtle			
3 Truck Cup Rabbit Ball Umbrella	Ball				Engine Ball Tree Clock Cat			
4 Dog Bottle Hat Flower Clock	Dog				Cone Car Rabbit Umbrella Dog			

The scoring form for Visual Memory (Objects) is not reproduced here because it is identical to the above form with the exception that the entries for the various sets are different. The prescribed arrangements for the objects in Visual Memory (Objects) are listed below with the Object Removed underscored.

	Original Set	New Set
1.	car, horse, block pencil	button, clock, horse, chair
2.	chair, airplane, crayon, key	key, car, box, pencil
3.	book, apple, clock, box	crayon, block, button, clock
4.	car, book, airplane, block	apple, key, car, horse
5.	pencil, key, crayon, button	clock, block, book, crayon

COLOR

Matching Colors was administered to Chula Vista kindergarten children only; Naming and Identifying appeared in all forms and in all inventories.

2

Matching Colors

I HAVE SOME COLOR CARDS. I AM GOING TO PUT THEM ON THE TABLE.

Arrange experimenter's color cards on table, from left to right: yellow, blue, brown, green, orange, red. Note that experimenter's set does not include black.

NOW I AM GOING TO PUT SOME ON THE TABLE FOR YOU, TOO.

Arrange pupil's cards on table with experimenter's, from left to right: orange, blue, red, black, brown, yellow, green. Pause for any spontaneous comments from pupil and record them in "Other Observations".

Touch your green card but do not name the color.

LOOK AT THE COLOR CARD I AM TOUCHING. NOW LOOK AT ALL OF YOUR COLOR CARDS. DO YOU HAVE ONE JUST LIKE IT?

If the child does not spontaneously point to his card, then say:

PUT YOUR FINGER ON THE COLOR CARD OF YOURS THAT IS JUST LIKE THIS ONE.

If pupil does not understand directions, or touches experimenter's card rather than his own, say:

PUT YOUR FINGER ON ONE OF THESE COLOR CARDS (pointing to his set) THAT IS JUST LIKE THIS ONE (the one I am touching).

Proceed in the order listed in the scoring sheets.

When Matching is completed, remove tester's set of color cards from table, and start color Naming.

Naming Colors

Point in order to the color cards, starting with orange, and say:

CAN YOU TELL ME THE NAME OF THE COLORS?
WHAT COLOR IS THIS?
AND THIS ONE?

When Naming is completed, leave color cards set up as they were for Naming and start Identification of colors.

Identifying Colors

WOULD YOU GIVE ME THE RED CARD?

Proceed, using order listed in the scoring sheet.

Scoring

Scoring for each of the above subtests on Color was accomplished on forms in which one column listed the colors to be tested. Three other columns were provided: one to be checked if the response was correct, one if the response was incorrect, and one if there was no response in reply to the question asked.

GEOMETRIC SHAPES

Matching Shapes was included in all kindergarten pretests and in the posttest for the kindergarten children in Chula Vista. Naming and Identifying Shapes were administered to all groups, kindergarten and first grades, in every inventory.

Matching Shapes

I HAVE SOME SHAPES HERE.

I AM GOING TO PUT THEM ON THE TABLE.

Place the set of shapes in front of you. Arrange from your left to right: square, circle, rectangle, triangle (with vertex toward the tester).

NOW I AM GOING TO PUT SOME ON THE TABLE FOR YOU, TOO.

Place the set of shapes, including the L-shaped region, from your left to right: rectangle, triangle, L-shape (orient L-shape to read as an L to child), square, circle.

Touch your circle but do not name it.

LOOK AT THE SHAPE I AM TOUCHING.

PUT YOUR FINGER ON THE SHAPE IN YOUR SET THAT IS JUST LIKE THIS ONE.

If child does not respond, or touches experimenter's shapes, say:

PUT YOUR FINGER ON ONE OF THESE SHAPES (pointing to child's set) THAT IS JUST LIKE THIS ONE (pointing to your circle).

Proceed with square, triangle, rectangle.

Naming Shapes

Leave shapes set up as they were for Matching.

CAN YOU TELL ME THE NAMES OF THE SHAPES?

WHAT IS THIS? (pointing to square in the child's set).

AND THIS? (pointing to triangle in the child's set).

THIS? (pointing to rectangle in the child's set).

WHAT IS THIS? (pointing to circle in the child's set).

Identifying Shapes

Leave shapes set up as they were for Matching and Naming.

WOULD YOU GIVE ME THE TRIANGULAR SHAPE?

WOULD YOU GIVE ME THE RECTANGULAR SHAPE?

NOW THE CIRCULAR SHAPE.

AND NOW THE SQUARE.

AND THE L-SHAPE.

Scoring

Scoring for Geometric Shapes was similar to that for Color. A column each was provided for listing of the shape tested, for correct response, incorrect response, and for no response.

NUMBER SYMBOLS

Writing and Identifying Number Symbols were administered to all groups and in every inventory. Naming Number Symbols was given only to the first grade children in the posttest.

Naming Number Symbols

I HAVE SOME CARDS HERE.

Show child the cards of Set I so that he can see the numerals.

THE CARDS HAVE NUMERALS ON THEM. THIS ONE HAS A 5 ON IT. WHEN I SHOW YOU A CARD, YOU TELL ME WHAT NUMERAL IS ON IT.

Show the child the next card and say:

WHAT NUMERAL IS THIS?

Continue in the order marked on the scoring sheet. Stop after two consecutive errors.

Identifying Number Symbols

I HAVE SOME ENVELOPES HERE. (First grade posttest used cards with printed numerals instead.)

Show envelope so that child can see numerals.

THIS ONE HAS SOME BUTTONS INSIDE. THIS (pointing to the numeral) TELLS US HOW MANY BUTTONS ARE INSIDE. THIS ONE HAS A 2 ON IT. IT HAS TWO BUTTONS IN IT.

Place envelopes marked 0 , 1 , 2 , 3 , 4 , 5 randomly on the table in front of child so that all the numerals can be clearly seen, and say:

GIVE ME THE ONE THAT HAS 3 BUTTONS INSIDE.

Continue, asking for 1 and 4 . Remove these envelopes.

If, after these trials, it is clear that the pupil cannot recognize the symbols, do not proceed.

If the child has been successful on one trial, randomly spread envelopes marked 0 , 2 , 5 , 6 , 7 , 8 , 9 on the table and proceed.

GIVE ME THE ONE THAT HAS 5 BUTTONS INSIDE.

Continue in the order marked on the scoring sheet.

Writing Number Symbols

This task was given at the same time as for Counting (Objects); the directions for both tasks are given below.

LET'S PUT SOME BUTTONS IN THESE BOXES.

Place a heap of buttons in front of the child and give him a box.

WILL YOU PUT TWO BUTTONS IN THE BOX? I WILL WRITE A "2" ON THIS CARD.

Write a "2" on the card, show child, and place it in the box with buttons.

NOW WE WILL KNOW HOW MANY BUTTONS ARE IN IT.

Place another box in front of child and say:

WOULD YOU PUT THREE BUTTONS IN THE BOX? (Pause.) WOULD YOU LIKE TO WRITE A "3" ON THIS CARD?

Give child crayon and pad if he is willing to try. If not, write it yourself.

Continue in the order listed on the scoring sheets. Stop after child has made two consecutive errors in counting.

Remove materials from table before beginning next section.

Scoring

On the scoring sheet, for each of these assessments, a sequence of numerals was repeatedly displayed in three rows. The tester was to circle the numeral in the first row if the numeral was named (identified, written) correctly. If named (identified, written) incorrectly, that numeral was circled in the second row; and if no attempt was made, in the third row.

COUNTING

Counting (Objects) was given to all groups in every inventory except in the posttest for the first grade. Counting (Pictures) and Rote Counting by Ones were included in all forms for each inventory. Rote Counting by Tens was given only in posttest for the first grade children.

Objects

This task was given at the same time as for Writing Number Symbols. For the specific directions, refer to the foregoing section.

Pictures

Place card in front of the child and say:

HOW MANY MEMBERS ARE THERE IN THIS SET?

If no response, say:

HOW MANY DRAWINGS ARE THERE ON THIS CARD?

Continue in the order and with the position of the card as marked on the back on each card.

Stop after the child has made two consecutive errors in counting.

Rote by Ones

WILL YOU COUNT FOR ME?

Pause, if no response, say:

I'LL START AND THEN YOU GO ON. 1, 2.

Pause. If still no response, say:

ONE . . . WHAT COMES NEXT?

Stop the child when he reaches "100" .

Rote by Tens

WILL YOU COUNT BY TENS FOR ME?

Pause, if no response, say:

I'LL START AND THEN YOU GO ON. 10 , 20 .

Pause. If still no response, say:

TEN . . . WHAT COMES NEXT?

Stop the child when he reaches 200.

Scoring

In scoring for Counting (Objects), a form was provided in which the number of buttons to be counted was listed in the first column. One column was provided for checking if the number of buttons was counted correctly, and one for checking if incorrectly counted.

For Counting (Pictures), numerals 1 through 8 were displayed corresponding to the Card Number. If the number of objects on a card were counted correctly, that card number was to be circled.

For Rote Counting by Ones, a display of numerals 1 through 100 was provided. Numbers omitted in the counting were to be circled and the last number counted was identified by placing the mark × on that numeral. The same system was used on Rote Counting by Tens with a display for 10 through 200 given in intervals of tens.

PLACE VALUE

Administered only in posttest for first grade children.

Naming Place Value

Arrange the seven bundles of 10 paste sticks in front of you and say:

EACH OF THESE BUNDLES HAS TEN PASTE STICKS.

Place two bundles of sticks in front of child and say:

HOW MANY STICKS DO YOU HAVE?

If child says two tens, record this in comments column, and say:

DO YOU KNOW ANOTHER NAME FOR TWO TENS?

Remove these bundles. Place five bundles of sticks in front of child and say:

HOW MANY STICKS DO YOU HAVE?

If child says five tens, record this in comments column, and say:

DO YOU KNOW ANOTHER NAME FOR FIVE TENS?

Repeat for six bundles and three bundles, and then proceed as follows.

Place three bundles and five single sticks in front of child and say:

HOW MANY STICKS DO YOU HAVE?

If child says three tens and five more or something equivalent, record in comments column and say:

DO YOU KNOW ANOTHER NAME FOR THIS?

Remove sticks and repeat with: 5 bundles and 7 ;
2 bundles and 4 ;
4 bundles and 7 ;
1 bundle and 9 ;
7 bundles and 5 .

Forming Place Value

Place the sticks in front of child: the ten bundles of ten in one heap toward child's left and the ten single sticks in another heap to child's right and say:

USING THE BUNDLES OF TEN AND THE SINGLE STICKS, MAKE A SET OF SIXTEEN STICKS.

When this task is complete, give child the crayon and pad and say:

WRITE THE NUMERAL 16 ON THIS PAD.

Note: This is given in the first grade in lieu of Writing Number Symbols task that follows Counting (Objects) in the other inventories.

Replace the sticks in their correct heaps, and repeat in the order listed on the scoring sheet.

Scoring

Scoring on both of these tasks was accomplished by circling on the given lists the place value numbers correctly named or formed.

ORDINAL NUMBERS

This portion of the test was administered to the kindergarten children in the final inventory and to the first grade children in both pretest and posttest. The same vocabulary was tested: first, second, third, fourth, fifth, last. Only the sequencing of the numbers varied between pretest and posttest.

HERE ARE SOME TRUCKS AND SOME MARBLES. I AM GOING TO LINE UP THE TRUCKS LIKE THIS.

Line up trucks with cabs of trucks at an angle toward pupil's right. (Five trucks were lined up with the front of each truck pointing toward the pupil along a diagonal from the tester's lower right to his upper left.)

Hand child a marble. Say:

WOULD YOU PUT THIS MARBLE IN THE FIRST TRUCK?

WOULD YOU PUT THIS MARBLE IN THE THIRD TRUCK?

Then say:

WOULD YOU PUT THIS MARBLE IN THE FIFTH TRUCK?

Proceed with fourth, first, last, second, fourth, in this order. When this task is completed, have child help in placing more marbles in the trucks so that there are three marbles in each truck.

GIVE ME ONE OF THE MARBLES FROM THE THIRD TRUCK.

NOW GIVE ME ONE FROM THE FIFTH TRUCK.

Proceed with fourth, second, last, third, first, fifth.

Scoring

Scoring was done on forms in which the first column listed the numbers to be tested in the prescribed sequence. A column each was provided for checking off whether the response was correct or incorrect.

In briefing the testers, it was suggested that the first two responses be pencilled in along the item listing at first. With five trucks in a row, it is not clear whether the child might be incorrect because he used the wrong reference point, identifying the fifth truck as the first, and so on. From the third item on, it should then be clear which truck was considered by the child to be the first truck, and the scoring was to be on the basis of the child's reference point.

PAIRING

Administered only to first grade children and only in final inventory.

HERE IS A PAPER (page 1) WITH A SET OF PICTURES ON ONE SIDE OF THE LINE.

Point to set on child's left side of the paper.

DO YOU SEE THE LINE?

Wait for affirmative response.

AND HERE IS ANOTHER SET OF PICTURES ON THE OTHER SIDE OF THE LINE.

Point to set on child's right side of paper.

I WANT YOU TO PAIR THE MEMBERS OF THIS SET (pointing to drawings on child's left) WITH THE MEMBERS OF THIS SET (pointing to drawings on the child's right side of the line).

Hand child the pencil. If no response, say:

USE THE PENCIL TO PAIR THE MEMBERS.

When the child has finished, say:

TURN THE PAGE AND DO THE SAME WITH THE SETS ON THIS PAGE (pointing to page 2). PAIR THE MEMBERS OF THESE SETS (pointing to sets on the left and right of the page).

When child has finished page 2, say:

HERE IS ANOTHER PAGE (pointing to page 3). PAIR THE MEMBERS OF THE SETS.

When child has finished page 3, say:

AND ONE MORE (pointing to page 4). PAIR THE MEMBERS OF THE SETS.

In scoring this section, comment whether child paired similar members first. Also note if child stops after pairing only one pair of members and must be told to pair other members.

Scoring

On the scoring sheet, three rows of the numerals 1 through 4 referred to the page number on the Pairing sheet. The numeral on the first row was to be circled if the sets on that page were paired correctly. The second row was for attempt made on that page, with the pairing incorrect; the third row was for no attempt.

EQUIVALENT SETS

This task was administered only in the final inventory for each group, kindergarten and first grade.

Heap the buttons to the child's left. Place the sheet of construction paper in front of him.

I AM GOING TO SHOW YOU SOME CARDS WITH BUTTONS OR DRAWINGS ON THEM.

Show the child Card 1 . Place it above his sheet of paper, and say:

ON THIS SHEET (point to his construction paper) MAKE A SET WITH THE BUTTONS, WHICH IS EQUIVALENT TO THIS SET (pointing to the number card).

If child does not respond, say:

MAKE A SET WITH YOUR BUTTONS ON THIS SHEET (point to construction paper) THAT HAS THE SAME NUMBER OF MEMBERS AS MY SET HAS (point to your number card).

Pause after child finishes, and remove buttons from his paper to the side of the table each time. Continue with the number cards in the order and position as marked on the back of each card.

Have on the table only the number card for which the child is constructing an equivalent set. Keep all other number cards off the table.

Stop after the child has made two consecutive errors in constructing sets.

Scoring

(Check two columns for each card)

			Equivalent set formed by:		
Card	Correct (√)	Incorrect (√)	(√) Copying Pattern	(√) Counting	(√) Other (Explain)
I					
II					
III					
IV					
V					
VI					

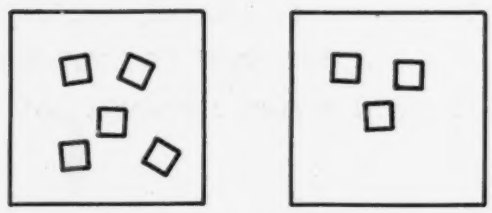
The form reproduced on the preceding page shows the procedure used for scoring Equivalent Sets. As noted in the instructions, each card was to be checked twice. One check was to be made to the left of the double line to indicate whether the task was accomplished correctly; another to the right of the double line to indicate the method by which the child arrived at his pairing regardless of whether it was done correctly.

VOCABULARY

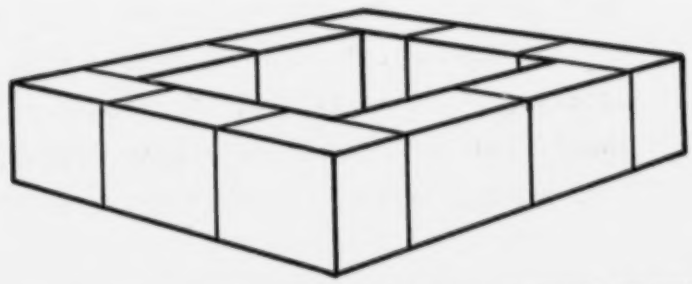
This assessment was made on the Chula Vista kindergarten posttest, all other kindergarten pretests and posttests, and all first grade pretests. Visual Recognition (Objects and Pictures) were used in the Chula Vista pretest in lieu of the assessment for Vocabulary. The same vocabulary was tested in both pretest and posttest for the kindergarten groups. With the exception that the words, "left" and "right" were not included in the first grade inventory, the vocabulary was the same as that in the kindergarten tests.

The specific directions presented below were those used in the final inventory for the Chula Vista kindergarten children.

Vocabulary	Directions
1. Behind	Hand child 1 block. CAN YOU PUT THIS BLOCK BEHIND YOU? If child does not respond, say: CAN YOU PUT THIS BLOCK BEHIND YOUR BACK SO THAT I CAN'T SEE IT?
2. Above	NOW HOLD THE BLOCK ABOVE YOU. If child does not respond, say: CAN YOU HOLD THAT BLOCK ABOVE YOUR HEAD?
3. Between	Hand child 4 blocks. WILL YOU BUILD A TOWER ON THE PAPER WITH THESE BLOCKS? If child does not start, say: STACK THEM UP LIKE THIS. And start stacking blocks. Stack 2 and tell child: YOU GO AHEAD AND PUT THE BLOCKS ON THE TOWER. If child has difficulty, don't push him; help him build the tower.

Vocabulary	Directions
	When tower is built, say NOW I AM GOING TO BUILD TWO MORE TOWERS. Build two more 4-block towers in a row on the paper next to the child's tower with a 3-inch separation between each two. WHICH IS THE TOWER BETWEEN THE OTHERS?
4. Each	CAN YOU TOUCH EACH TOWER?
5. Remove	ALL RIGHT, NOW I WANT YOU TO REMOVE THE BLOCKS FROM THE PAPER.
6. Set	Put all blocks in a heap at the side of the table to your right. Have your pen or pencil and papers on the table. Place the sheet of construction paper in front of the child. NOW, I WANT YOU TO MAKE A SET HERE ON THE PAPER. Point to the construction paper. Any collection of objects--blocks, pencils, etc., placed on the paper is acceptable. If child does not respond, say: PUT A SET OF THESE OBJECTS (pointing to objects) ON THIS PAPER (pointing to sheet of paper).
7. More than	Place two pieces of construction paper, with 3 inches between the two sheets, in front of the child. HERE ARE TWO SHEETS OF PAPER. I AM GOING TO PUT SOME BLOCKS ON THIS SHEET OF PAPER. Place three blocks on sheet to your right. YOU PUT MORE BLOCKS ON YOUR PAPER (pointing to empty sheet) THAN I PUT ON THIS (pointing to your sheet). If child cannot do this task, place five blocks on empty paper, say: NOW, WHICH PAPER HAS MORE BLOCKS ON IT THAN THE OTHER PAPER? 

Vocabulary	Directions
	If child does not respond, say: WHICH OF THESE PAPERS (pointing to the two sheets) HAS <u>MORE</u> BLOCKS ON IT?
8. As many as	Leave the two sheets of paper in front of the child. Have blocks heaped at the side of the table. Place 4 blocks on paper to your right. I AM PUTTING SOME BLOCKS ON THIS PAPER. YOU PUT <u>AS MANY</u> BLOCKS ON THIS PAPER (pointing to empty sheet) <u>AS</u> I HAVE PUT ON THIS PAPER (pointing to sheet with blocks on it).
9. Fewer than	Leave the two sheets of paper in front of the child. Have all the blocks heaped at the side of the table. Place 5 blocks on the paper to your right. I HAVE A SET OF BLOCKS ON THIS PAPER (pointing to the paper with blocks). YOU PUT A SET WITH <u>FEWER</u> BLOCKS <u>THAN</u> THIS (again pointing to paper with blocks) HERE (pointing to empty sheet). If child does not respond, say: PUT <u>FEWER</u> BLOCKS ON THIS PAPER <u>THAN</u> I HAVE PUT ON THIS PAPER. If child still cannot do the task, score as "not attempted" and place three blocks on the empty sheet.
10. Join	NOW, <u>JOIN</u> THESE TWO SETS OF BLOCKS. If child does not respond, say: CAN YOU <u>JOIN</u> THIS SET OF BLOCKS (pointing to blocks on paper to your left) TO THIS SET OF BLOCKS (pointing to blocks on paper to your right)? In scoring this item, comment whether child moved blocks from <u>his</u> left to right, <u>his</u> right to left, or both sets to the middle.
11. Below	Hand child 1 block. CAN YOU HOLD THAT BLOCK <u>BELOW</u> YOUR CHIN? If child does not respond, say: CAN YOU POINT TO YOUR CHIN? If child cannot correctly point to his chin, hold your

Vocabulary	Directions
	hand, palm down, over the table at the height of the child's chin, and say: CAN YOU HOLD THE BLOCK <u>BELOW</u> MY HAND?
12. Left	Place 1 block on the table in front of the child. CAN YOU HOLD THE BLOCK IN YOUR <u>LEFT</u> HAND?
13. Outside	Make a rectangular-shaped construction, using <u>10</u> blocks, in front of the child.
	 I AM BUILDING A WALL. CAN YOU PUT THIS BLOCK <u>OUTSIDE</u> THE WALL?
	Hand the child 1 block.
14. Inside	NOW, PUT THAT BLOCK <u>INSIDE</u> THE WALL.
15. On	PUT THE BLOCK <u>ON</u> THE WALL.
16. Right	Place 1 block on the table in front of the child. CAN YOU HOLD THE BLOCK IN YOUR <u>RIGHT</u> HAND?

<u>Scoring</u>

Scoring for this assessment consisted of entries in a chart with the vocabulary being tested listed in one column and with additional columns for checking according to whether the response was correct or incorrect. As with other tasks, space was provided for comments for each item in the assessment.

<u>ORDERING AND CLASSIFYING</u>

Assessments for Ordering and Classifying were made on all forms and for every group except for the initial inventory of the Chula Vista kindergarten classes.

In the pretest, the forms for the kindergarten and for the first grade were different; the classification tasks for the first grade being along two or more dimensions, while some classifying required of the kindergarten children were along one dimension (for example, color), and some were along more than one dimension (for example, simultaneously by size and shape).

The posttest for this section of the kindergarten inventory was identical to the one for the first grade. This assessment was an extension of the initial inventories both in length and complexity.

As an indication of the kinds of tasks required in the Ordering and Classifying section, the assessment for the kindergarten pretest is reproduced below. Items aimed at assessing ordering only or classifying only are intermixed with those assessing both ordering and classifying. In the specific directions to follow, identification of the particular type of assessment will be indicated accordingly within brackets, [ ] .

Part 1.

Spread out the geometric shapes of Set I randomly in front of the child so that all are visible.

HERE ARE SOME SHAPES OR REGIONS. YOU FIND ALL THE TRIANGLES, AND PUT THEM HERE (pointing to the child's right).

Count the number the child finds and record [classifying]. If child does not respond, say:

SHOW ME A TRIANGLE. (Pause.) NOW PUT ALL THE TRIANGLES OVER HERE (pointing to the child's right).

If child still cannot identify a triangle, point to one of the middle-sized triangles, and say:

THAT IS A TRIANGLE.

Be certain to write down in comments on the score sheet if it is necessary for you to identify the triangle for the child.

Count the number the child finds and record.

Add any triangle the child has overlooked to his set of triangles. If child has included shapes other than triangles in his set, note number and shape of these in comments on the score sheet.

Remove all the shapes except the 4 triangles from the table, and say:

CAN YOU PUT THESE (pointing to triangles) IN A LINE SO THAT THEY GO FROM THE SMALLEST TO THE LARGEST? [ordering]

GIVE ME THE SMALLEST TRIANGLE. [ordering]

Part 2.

Spread out the geometric shapes of Set II randomly in front of the child so that all are visible.

HERE ARE SOME OTHER SHAPES. HAND ME THE SHAPES THAT ARE CIRCLES AND YELLOW.

Be certain to write down in comments if other shapes were included [classifying]. Note the shape and color of noncircular shapes included in the set. Note if other-colored circles were included.

Count the number of yellow circles the child finds and record. Add any yellow circle the child has overlooked. Remove all shapes except the 4 yellow circles from the table, and say:

CAN YOU PUT THESE (pointing to the circles) IN A LINE SO THAT THEY GO FROM THE SMALLEST TO THE LARGEST? [ordering]

GIVE ME THE SMALLEST CIRCLE. [ordering]

Part 3.

Spread out the shapes of Set III randomly in front of the child so that all are visible.

HERE ARE SOME OTHER SHAPES OR REGIONS.

THERE ARE 4 DIFFERENT SHAPES IN THE SET. (Point to one of each shape.)

GIVE ME THE SMALLEST ONE OF EACH DIFFERENT SHAPE. [ordering and classifying]

If child does not respond, say:

MAKE A SEPARATE PILE FOR EACH SHAPE. (Point again to one of each shape.)

THEN GIVE ME THE SMALLEST OF EACH SHAPE.

Be certain to note in comments if it is necessary to tell the child to do this.

Note in comments if error was made, which smallest shape was omitted or if any larger ones were included. [ordering]

Scoring

For each of the three parts in Ordering and Classifying, the scoring consisted of charts in which the number of objects to be sorted,

triangles in Part 1,

yellow circles in Part 2,

smallest member of each shape in Part 3,

was identified by circling the appropriate numeral, 0 through 4 .

Another entry in Parts 1 and 2 recorded whether the child ordered from smallest to largest correctly, and another entry (also in Parts 1 and 2) recorded whether the child handed the smallest object (triangle, circle) correctly. For Part 3 , the tester was asked to indicate the kind of error made in sorting, if an error was made. Alternatives provided here listed possibilities of a shape being omitted and of a larger shape being included with the set of "smallest of each shape".

APPENDIX C

Interitem Reliability

For a determination of interitem reliability, the Kuder-Richardson coefficient of equivalence was calculated for each item. These results are displayed in the table below.

		Kindergarten		First Grade	
		Initial	Final	Initial	Final
Visual Memory	Objects	0.263	0.316	-0.080	
	Pictures	0.318	0.402	0.409	0.182
Color	Naming	0.833	0.710	0.741	0.730
	Identifying	0.896	0.847	0.868	0.910
Geo-metric Shapes	Matching	0.614			
	Naming	0.468	0.268	0.419	0.313
	Identifying	0.493	0.670	0.473	0.641
Number Symbols	Writing	0.845	0.819	0.701	0.875
	Naming				0.924
	Identifying	0.837	0.782	0.813	0.899
Count-ing	Objects	0.908	0.865	0.708	
	Pictures	0.867	0.829	0.756	0.819
Place Value	Naming				0.954
	Forming				0.948
Ordinal Numbers			0.909	0.853	0.898
Pairing					0.888
Equivalent Sets			0.778		0.642
Vocabulary		0.222	0.628	0.524	
Ordering		0.146	0.487	0.612	0.287
Classifying		0.647	0.405	0.550	0.382
Ordering-Classifying		0.003	0.313	0.466	0.337

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W. G. C.